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Acute Effects of a High-Protein Breakfast on Attention and Satiety Among University Students

Muhammad Hazim Aiman Ramlan¹, Nurul Ain Abu Kasim¹, & Muhamad Safiq Saiful Annur^{1*}

¹Faculty of Sports Science and Recreation, Universiti Teknologi MARA Negeri Sembilan, Seremban Campus, Malaysia

*Corresponding author: msafiq@uitm.edu.my

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I. INTRODUCTION

Breakfast intake has long been considered an important component of daily nutritional adequacy and optimal cognitive functioning [1][2]. Among different breakfast compositions, high-protein breakfasts have gained increasing research attention due to their potential to enhance satiety and sustain cognitive concentration throughout the morning [3][4]. University students are particularly vulnerable to breakfast omission because of academic workload and time constraints, which may negatively affect attention, memory, and appetite regulation [1]. Although the relationship between breakfast intake, cognition, and satiety has been explored in previous studies, limited research has directly examined the acute effects of a high-protein breakfast compared with breakfast omission among young adults [4][5]. Therefore, the aim of this study was to determine the acute effects of a high-protein breakfast on attentional performance and perceived satiety compared with no breakfast among university students.

II. METHODS

A total of 34 university students voluntarily participated in the study. The experiment was conducted as a within-subject crossover design, in which each student completed both the high-protein breakfast condition and the no-breakfast, fasted condition. A three-day washout period was used to minimise carry-over effects between conditions. The high-protein breakfast consisted of approximately 30 to 35 g of protein. Under the fasted condition, students skipped breakfast before testing. All testing sessions were conducted in the morning. Acute effects were examined by assessing cognitive performance and satiety approximately 60 minutes after the high-protein breakfast or after an equivalent fasting period in the no-breakfast condition.

The Stroop Test was administered as an assessment of attention, while the Visual Analogue Scale was used to assess satiety. All tests were performed in the morning at the same time points after either consuming breakfast or remaining fasted, allowing the immediate effects of each condition to be observed. All tests were administered at 30, 60, 120, 180, and 240 minutes after the breakfast and no-breakfast conditions.

Data were analysed using SPSS. Paired-samples t-tests were conducted to compare attention and satiety scores between the high-protein breakfast and no-breakfast conditions, with the significance level set at $p < .05$.

III. RESULTS AND DISCUSSION

Table I presents the results of paired-samples t-tests comparing attention scores at baseline and after 30, 60, 120, 180, and 240 minutes in each experimental condition. Under the high-protein breakfast condition, statistically significant changes in attention scores were found at all post-baseline intervals ($p < .001$). The highest mean difference was observed at the 120-minute interval, indicating the strongest improvement in attentional performance compared with baseline. These findings are consistent with previous research demonstrating that high-protein breakfast consumption can enhance cognitive concentration during the late morning period [4][5].

TABLE I
PAIRED-SAMPLES T-TEST RESULTS FOR ATTENTION SCORES

Condition	Time	Mean $\pm$ SD	t	df	p-value
High-Protein Breakfast	Baseline - 30 Minutes	-10.58 $\pm$ 9.71	-6.352	33	< .001
	Baseline - 60 Minutes	-14.60 $\pm$ 8.02	-10.61	33	< .001
	Baseline - 120 Minutes	-17.81 $\pm$ 8.49	-12.23	33	< .001
	Baseline - 180 Minutes	-14.44 $\pm$ 9.56	-8.81	33	< .001
	Baseline - 240 Minutes	-13.63 $\pm$ 9.86	-8.06	33	< .001
No-Breakfast	Baseline - 30 Minutes	-10.68 $\pm$ 10.37	-6	33	< .001
	Baseline - 60 Minutes	-15.91 $\pm$ 10.17	-9.12	33	< .001
	Baseline - 120 Minutes	-18.30 $\pm$ 8.10	-13.17	33	< .001
	Baseline - 180 Minutes	-15.37 $\pm$ 8.53	-10.51	33	< .001
	Baseline - 240 Minutes	-14.02 $\pm$ 9.04	-9.04	33	< .001

Significant level set at $p < .05$

A similar temporal trend was observed in the no-breakfast condition, with attention scores also showing significant changes compared with baseline at all time points ($p < .001$). Such within-condition improvements may reflect practice effects or natural

fluctuations in alertness over time, as reported in breakfast cognition studies involving repeated cognitive testing [1]. However, it is important to note that these analyses reflect only within-condition time effects and do not directly address the primary hypothesis concerning between-condition differences in attentional performance between the high-protein and no-breakfast groups.

TABLE II
PAIRED-SAMPLES T-TEST RESULTS FOR SATIETY SCORES

Condition	Time	Mean $\pm$ SD	t	df	p-value
High-Protein Breakfast	Baseline - 30 Minutes	-4.54 $\pm$ 2.60	-10.18	33	< .001
	Baseline - 60 Minutes	-3.54 $\pm$ 2.37	-8.7	33	< .001
	Baseline - 120 Minutes	-1.76 $\pm$ 2.36	-4.35	33	< .001
	Baseline - 180 Minutes	-1.15 $\pm$ 2.42	-2.76	33	0.009
	Baseline - 240 Minutes	-1.99 $\pm$ 3.06	-0.379	33	0.707
No-Breakfast	Baseline - 30 Minutes	0.18 $\pm$ 1.36	0.789	33	0.436
	Baseline - 60 Minutes	0.10 $\pm$ 2.00	0.279	33	0.782
	Baseline - 120 Minutes	-0.29 $\pm$ 2.77	-0.619	33	0.54
	Baseline - 180 Minutes	1.02 $\pm$ 3.31	1.8	33	0.081
	Baseline - 240 Minutes	2.79 $\pm$ 2.90	5.6	33	< .001

Significant level set at $p < .05$

Table II presents the paired-samples t-test results for satiety scores across time points within each condition. In the high-protein breakfast condition, satiety scores were significantly higher at 30, 60, 120, and 180 minutes compared with baseline ($p < .05$), with no significant difference at 240 minutes, suggesting a gradual attenuation of the satiety response over time. These findings align with established evidence indicating that high-protein breakfasts enhance short-term satiety through hormonal and appetite-regulation mechanisms [3][4].

In contrast, the no-breakfast condition did not demonstrate significant increases in satiety during the earlier time points. A significant difference emerged only at 240 minutes ($p < .001$), likely reflecting increased hunger sensations over prolonged fasting. This pattern is consistent with literature showing that breakfast omission is associated with reduced early-day satiety and increased appetite later in the morning [1][3].

Overall, the results indicate that high-protein breakfast consumption elicited a stronger and more immediate satiety response compared with no breakfast, supporting previous findings on protein-induced appetite control [3][5]. Although attentional performance improved over time in both conditions, not statistically significant between-condition

differences were observed. This finding partially contrasts with some prior studies reporting cognitive advantages of breakfast consumption [2][4], suggesting that the acute cognitive benefits of a high-protein breakfast may depend on task sensitivity, participant characteristics, or study design.

IV. CONCLUSIONS

The findings of the present study indicate that a high-protein breakfast significantly enhanced subjective satiety but had a weaker effect on attentional performance among university students. Although attention scores showed slight improvements under the high-protein condition compared with no breakfast, these differences were not statistically significant. This pattern is consistent with previous research demonstrating stronger effects of dietary protein on appetite regulation than on cognitive outcomes [1][3]. Fullness ratings remained elevated across all postprandial intervals following the high-protein breakfast, supporting evidence that protein intake promotes sustained satiety through hormonal and neural appetite-control mechanisms [4][5]. While cognitive improvements were not statistically confirmed, the observed trend suggests potential benefits that warrant further investigation [2]. Overall, these findings highlight that breakfast composition, particularly protein content, plays a more critical role in appetite regulation than in short-term attentional enhancement.

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